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LIFE AND WORK ON BOARD A SPACE STATION

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16. Abstract

This article reviews the daily routine of the Soyuz-16--Salyut-3 cosmonauts and discusses their medical and exercise program. The cosmonaut's working day begins at about 9:00 A.M. and ends at about 1:00 A.M. The medical equipment used included: "Polinom" for recording EKG, arterial "Reseda" for determining pulmonary ventilation and volume; and "Impuls" for evaluating vestibular apparatus function by determining threshold amounts of electrical stimulation creating an illusion of pitching. The taste sensitivity of the tongue was also examined; reconstitution of freeze-dried food was studied. The exercise (TNK-1) and anti-gravity (TNK-2) suits are described; an anti-gravity suit at 40 - 59 mm Hg was worn during and after reentry.

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LIFE AND WORK ON BOARD A SPACE STATION

I. Pestov

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The orbiting stations established in recent years have significantly extended our resources for the conquest of cosmic space, and the contribution of space researchers to science and the national economy is becoming more and more noticeable. Cosmic medicine has had an opportunity of making a comprehensive study of the vital activity and the efficiency of the human organism under the unusual conditions of weightlessness and working out methods of control and normalization of changes resulting from the effects of weightlessness.

The flight of Soviet cosmonauts in the orbiting station Salyut-3 represented a concentration of the most recent achievements of science and technology and permitted fuller utilization of human creative potentialities in the solution of a variety of scientific-technological, and economic problems.

How were the work and life of the cosmonauts organized, and what were the results of the medical studies conducted during the flight?

On board the orbiting station, the daily routine for the members of the crew provides for a total of eight hours' (simultaneous) sleep, to coincide with the nocturnal period by Moscow time, thus

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* Numbers in margin indicate pagination in original foreign text.

preserving the accustomed circadian rhythm of their physiological processes, and providing natural conditions for the cosmonauts' rest. The working day begins about 9 o'clock and continues until one at night. In the course of the day, time is set aside for personal hygiene, for three meals a day, for the performance of physical exercises, for carrying out a number of studies and experiments (some of them medical), as well as for relaxation, reading, listening to magnetic tapes, for games of chess, and for simply feasting one's eyes through a porthole on the unaccustomed sights of the cosmos.

During the course of the first few days of the flight in space, the cosmonauts went through the already familiar process of adaptation to weightlessness. In the absence of gravity, the blood vessels of the upper half of the body, including those in the head, receive an increased supply of blood, which gives rise to a sensation similar to that experienced by a person on the ground when lying down with the head inclined slightly downward. The face also changes somewhat because of the edema of its tissues and the reddening of the skin. The cosmonauts observed during this period that inclining the head forward increased the sensation of weight in the head, since this impeded the flow of blood in the veins. Leaning the head backward rapidly reduced the sensation of a rush of blood to the head.

Knowing that during the period of adaptation, abrupt movements can lead to the appearance of symptoms of vestibulary disorders, during the first period the cosmonauts tried to work, as they put it, "without haste", making each motion economically and smoothly. This approach justified itself fully, since the cosmonauts displayed no symptoms of vestibulary disturbances. Appetite was good during the entire length of the flight, the crew members praised the gustatory qualities of the foodstuffs composing their on-board food ration. Especially flattering responses were accorded the

honey-cakes, the pâté Riga and the sauce moldave which made an excellent seasoning for the meat dishes.

After a week spent under conditions of weightlessness, the process of adaptation was complete. The sensation of heaviness in the the head and the edema of the facial tissues were reduced, rapid movement became possible, and even such acrobatic exercises as cartwheels, somersaults. The activity of the cosmonauts during this period was characterized by high productivity and great accuracy. They performed complex medical experiments completely professionally. Using the "Polinom" multifunctional apparatus, they took electrocardiograms in what are known as standard, strenuous and pectoral, conducted telemeter checks of their arterial blood pressure, of the phase structure of the cardiac cycle, the propagation rate of the pulse wave in arterial blood vessels. On the basis of this information, scientists can determine the effect of weightlessness on the contractile characteristics of the heart and, if one can /39 so express oneself, its productivity, that is to say, the amount of blood pumped into the aorta per contraction or per unit of time.

The experiment with the "Levka" apparatus was designed to study the characteristics of the blood circulation in the brain during weightlessness. During the course of the flight, samples were also taken of capillary blood and of exhaled air for subsequent laboratory analysis back on Earth.

Using the portable spirometer "Reseda", the cosmonauts determined the vital capacity of light, respiratory volume, the amount of pulmonary ventilation, i.e., the amount of air used in breathing per unit of time, e.g., in one minute.

The device "Impul's" was used to evaluate the functional state of the vestibulary apparatus, in particular, the threshold values of electrical stimulation to produce the illusion of tilting.

With a view toward further improvement of on-board rations, work was done during the flight on the reconstitution of dehydrated sublimed foodstuffs, and the indices of taste sensations on the tongue were studied. In addition, a study was made of the reaction of the cardiovascular system to doses of physical stress as a check on the physical training level of the members of the crew. The physical exercises, to the performance of which two hours of the daily schedule were allotted (two activities, each continued for one hour), were standardized, in particular, with the calculated result of this study.

It should be specially noted that the physical exercises gave the cosmonauts great satisfaction. For the performance of these exercises on board the orbiting station, use was made of the complex KTF training machine, consisting of a "running track" and gravity system. Before beginning the activity, the cosmonaut would put on the TNK-1 fatigue suit, to the belt of which, at both sides, were attached elastic cords from the training machine's gravity system. Thanks to this, the cosmonaut could apply his feet to the "running track" with a force of 50 kg and was thus able not only to stand on it, but even to walk on it, run, squat, jump, and perform many other exercises. The force exerted by the gravity system on the belt section of the body was partly transmitted to the shoulders so that merely being in the training machine in a standing position would evoke in the cosmonaut the sensation of weight and of vertical position.

The possibility of walking and running in a state of weightlessness turned out to be especially attractive. During these activities, the members of the crew felt very close to the genuine sensation of terrestrial conditions. It is of interest to note that after the training activity, there was a significant reduction in the unpleasant sensation of a rush of blood to the head, which, as aforementioned, characterized the initial period of weightlessness.

This was obviously connected with the fact that the creation of a load on the musculature of the lower extremities brought about an increase in blood circulation to this region, thereby diverting blood from the top half of the body.

Another means of maintaining the physical condition of the cosmonauts during the flight was the use of the TNK-2 fatigue suit for everyday wear. The peculiarity of this suit is that the stress elements in its construction create a constant static load along the longitudinal axis of the body, thus maintaining the tone of the so-called anti-gravitation musculature, i.e., those groups of muscles that under terrestrial conditions oppose the force of gravity and make possible the maintenance of an upright position.

The cosmonauts gave a positive evaluation of this suit, which formed part of the system of prophylactic devices.

The members of the crew devoted a great deal of attention to medical control, checking their own pulse rate, respiration, arterial pressure, and the muscular strength of their hands. These observations, which they regularly transmitted to Earth, bore witness to the fact that these indices had not undergone any significant changes during the flight.

One of the serious difficulties regularly arising during the first period after touchdown was the appearance of orthostatic disturbances, giving rise to difficulty in maintaining a vertical position. The cause of these disturbances lies in the fact that, because of its own weight, the blood accumulates in the lower half of the body, and this, in turn, interferes with the return of blood to to the heart and, hence, with the supply of blood to the brain. To alleviate these disturbances, the cosmonauts were advised even before their descent to put on suits analogous in principle to the anti-G suit. In accordance with the new area of application, they received the designation of post-flight prophylactic suits. The pressure

maintained in the chambers of these suits after touchdown, amounting to 40-50 mm Hg, is transmitted to the soft tissues of the lower extremities and prevents the accumulation of blood in these when shifting from a horizontal to a vertical position. It was found that the use of these suits significantly improved the ability to maintain a vertical position immediately after touchdown.

However, the necessity for them soon passed off. The process of readaptation took place very rapidly for P. R. Popovich and Yu. P. Artiukhin. Only at first did they experience a certain weakness together with a sensation of increased body weight. A hypercritical examination might reveal signs of uncertainty in their walk. However, two hours after landing, the cosmonauts' movements were already considerably more active. Their postflight medical examination revealed only moderate functional changes characteristic of the readaptation period, and which rapidly subsided in the next few days.

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